

# STRUCTURAL DESIGN II

## 03. DESIGN OF WELDED CONNECTION

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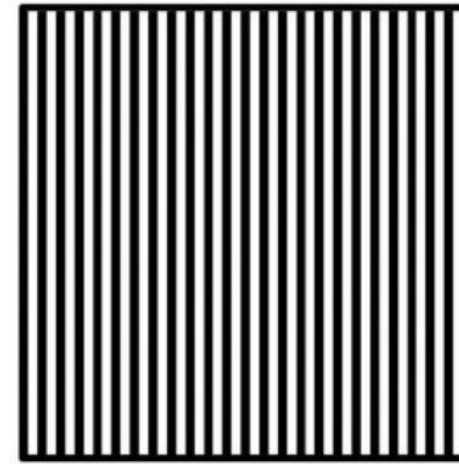
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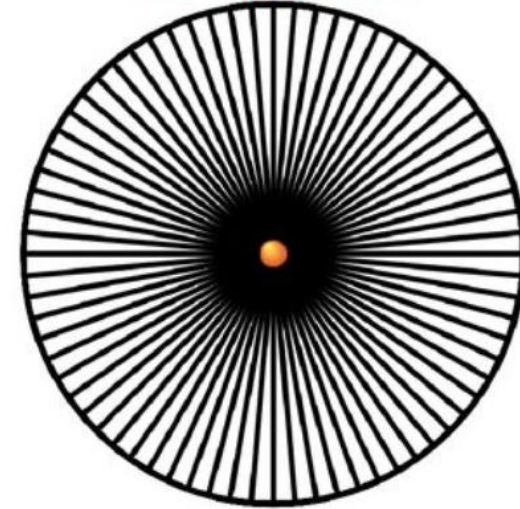
# ASSUMPTIONS IN DESIGN OF WELDS

- The **welds** connecting the various parts are *homogenous*, *isotropic*, and *elastic*.
- The **parts** connected by the welds are *rigid* and hence, its *deformation* is *negligible*.
- Only **stresses** due to external forces are considered (The effects of residual stresses, stress concentrations, and the shape of the weld are neglected).

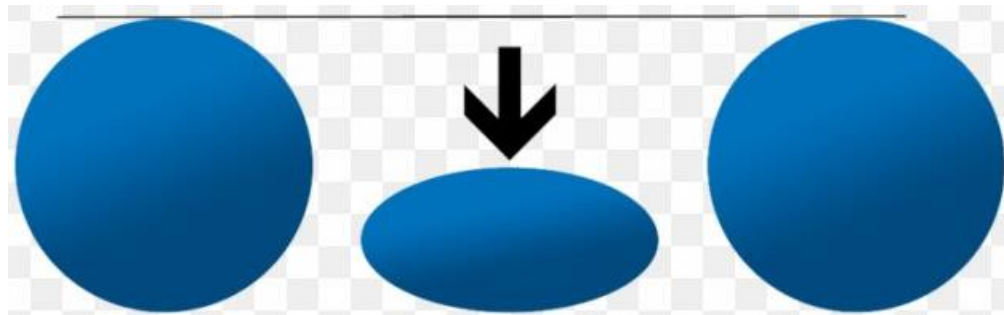
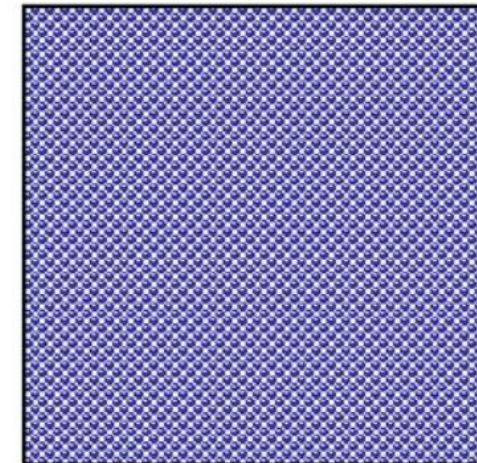
HOMOGENEOUS



ISOTROPIC



HOMOGENEOUS & ISOTROPIC



ELASTIC  
BODY

# DESIGN OF GROOVE WELDS

- The groove welds in butt joints will be treated as **parent metal with a thickness equal to the throat thickness** and the stresses shall not exceed those permitted in the parent metal. (Cl. 10.5.7.1.2)
- Here, failure occurs by **yielding of weld material**. Hence, yield strength ( $f_y$ ) is considered.
- Groove welds may be subjected to – Tension, Compression & Shear.
- Design strength of weld subjected to **tension or compression**

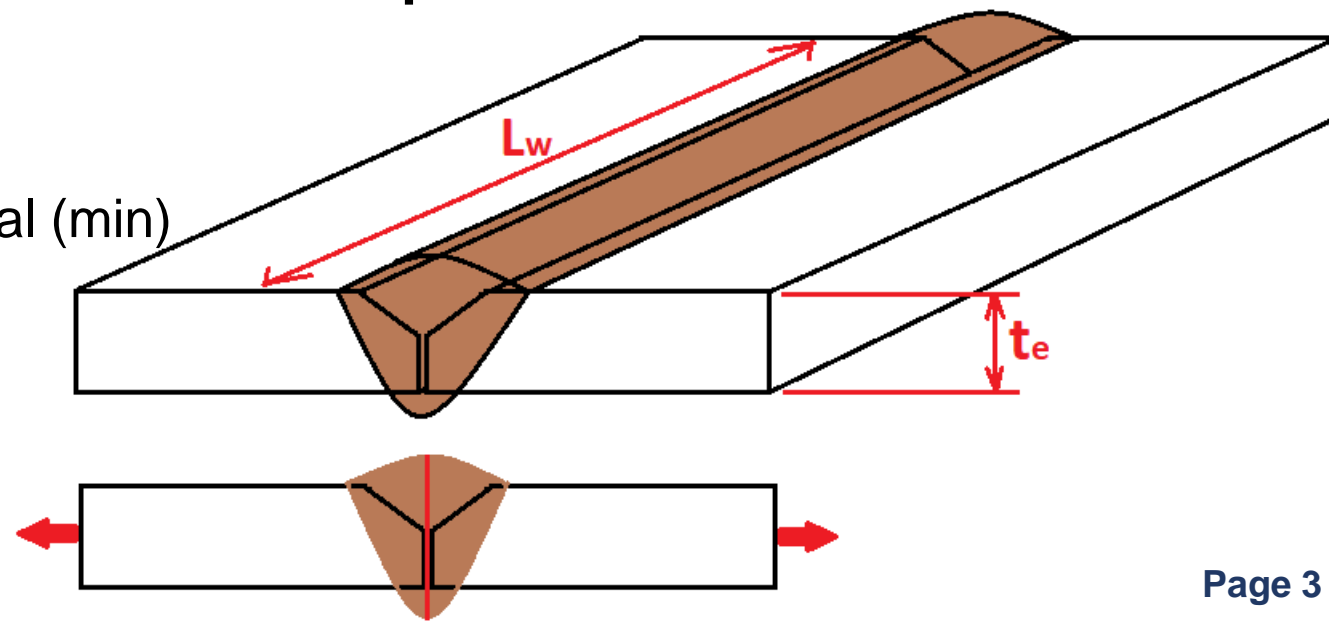
$$T_{dw} = \frac{f_y L_w t_e}{\gamma_{mw}}$$

$f_y$  = yield stress of weld or parent metal (min)

$L_w$  = effective length of weld

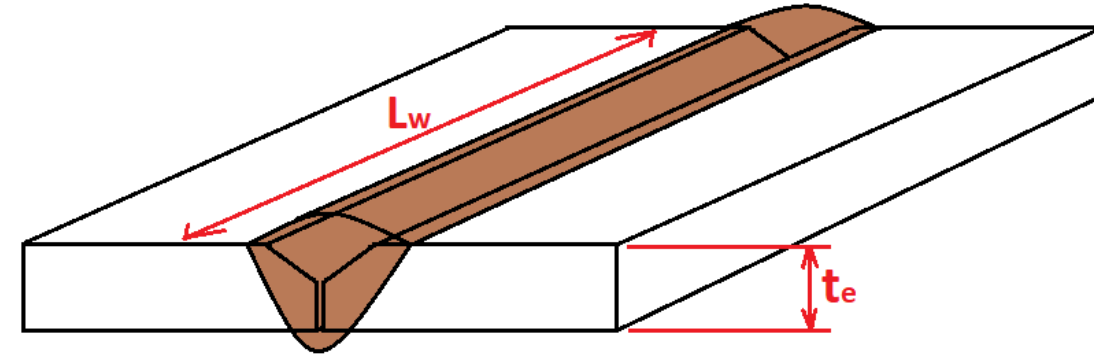
$t_e$  = effective throat thickness of weld

$\gamma_{mw}$  = partial safety factor for weld

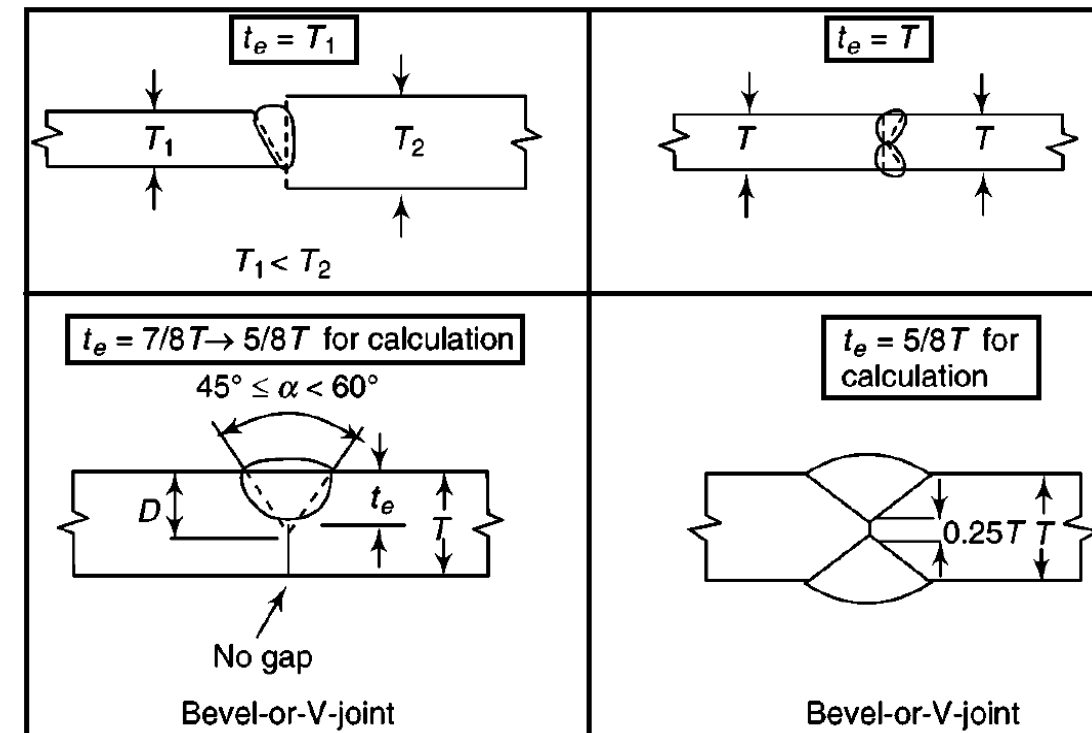


- Design strength of weld subjected to **shear**

$$V_{dw} = \frac{f_y L_w t_e}{\sqrt{3} \gamma_{mw}}$$



- The **effective throat thickness** ( $t_e$ ) is computed as shown here.
- The **effective length of weld** ( $L_w$ ) shall be taken as the length of the continuous full-size weld, but **not less than four times the size of the weld**. (Cl. 10.5.4.2)



# DESIGN OF FILLET WELDS

- Here, failure occurs by **rupture of weld material**. Hence, ultimate strength ( $f_u$ ) is considered.
- Since fillet weld **fails only in shear**, the design strength is given by: (Cl. 10.5.7.1.1)

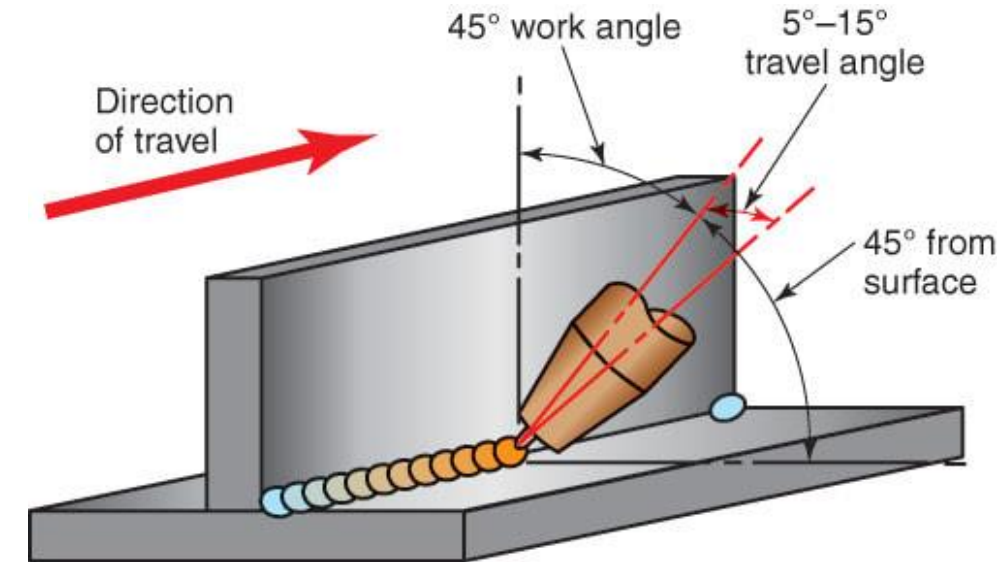
$$V_{dw} = \frac{f_u L_w t_e}{\sqrt{3} \gamma_{mw}}$$

$f_u$  = ultimate strength of weld or parent metal (min)

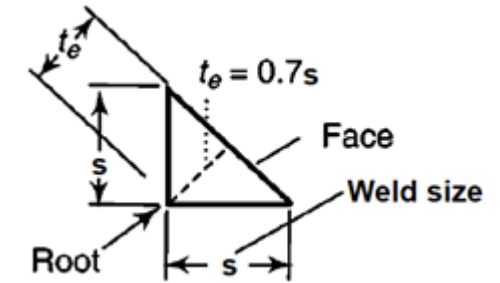
$L_w$  = effective length of weld

$t_e$  = effective throat thickness of weld

$\gamma_{mw}$  = partial safety factor for weld



- The **effective throat thickness** of a fillet weld is the shortest distance from the root to the face of the weld (shown below welds have fusion faces perpendicular to each other).
- The **size of fillet welds** shall not be less than 3 mm. The minimum size of the first run or of a single run fillet weld shall be as given in Table 21 (Page 78 - Cl. 10.5.2.3).
- In practice, the **actual length of weld** must be the effective length plus two times the weld size, but not less than four times the size of the weld. (Cl. 10.5.4.1)
- **End Returns:** Fillet welds terminating at the ends or sides of parts should be returned continuously around the corners for a distance of not less than twice the size of the weld. (Cl. 10.5.1.1)

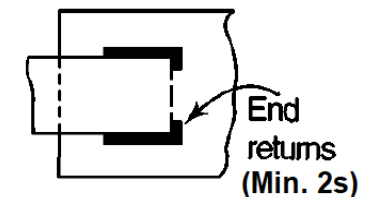


Sl No.	Thickness of Thicker Part mm		Minimum Size mm
	Over	Up to and Including	
(1)	(2)	(3)	(4)
i)	—	10	3
ii)	10	20	5
iii)	20	32	6
iv)	32	50	8 of first run 10 for minimum size of weld

#### NOTES

1 When the minimum size of the fillet weld given in the table is greater than the thickness of the thinner part, the minimum size of the weld should be equal to the thickness of the thinner part. The thicker part shall be adequately preheated to prevent cracking of the weld.

2 Where the thicker part is more than 50 mm thick, special precautions like pre-heating should be taken.





# NUMERICAL EXAMPLE 1

Two Fe410 plates of thickness 14mm & 12mm are joined by groove weld over an effective length of 150mm and subjected to factored tensile force of 350kN. Check the safety of the joint if it is (i) a single V-groove weld (ii) a double V-groove weld.

Answer:

Design strength of groove weld in tension,  $T_{dw} = \frac{f_y L_w t_e}{\gamma_{mw}}$

$f_y$  = 250 N/mm<sup>2</sup> (As per IS2062, min. yield strength = 250N/mm<sup>2</sup> for Fe410 grade plates of <20mm thickness)

$L_w$  = 150mm

$\gamma_{mw}$  = 1.25 (assume shopweld)

$t_e$  = (i) partial penetration weld =  $5t/8 = 5 \times 12/8 = 7.5\text{mm}$

(ii) complete penetration weld = 12mm

PARTIAL PENETRATION WELD



COMPLETE PENETRATION WELD



(i) Design strength for partial penetration weld,  $T_{dw} = \frac{250 \times 150 \times 7.5}{1.25} = 225000 \text{ N} = 225\text{kN} < 350\text{kN} \Rightarrow \text{Unsafe}$

(applied force)

(ii) Design strength for complete penetration weld,  $T_{dw} = \frac{250 \times 150 \times 12}{1.25} = 360000 \text{ N} = 360\text{kN} > 350\text{kN} \Rightarrow \text{Safe}$

(applied force)

# NUMERICAL EXAMPLE 2

A tie member in a truss girder is 250mm x 14mm size, welded to a 10mm thick gusset plate, with an overlap of 300mm. Design the weld if it transmits a factored force of 650kN.

Answer:

Design strength of fillet weld,  $V_{dw} = \frac{f_u L_w t_e}{\sqrt{3} \gamma_{mw}}$

$f_u$  = 410 N/mm<sup>2</sup> (assume Fe410 grade plate)

$L_w$  = unknown

$\gamma_{mw}$  = 1.25 (assume shopweld)

$t_e$  = 0.7s

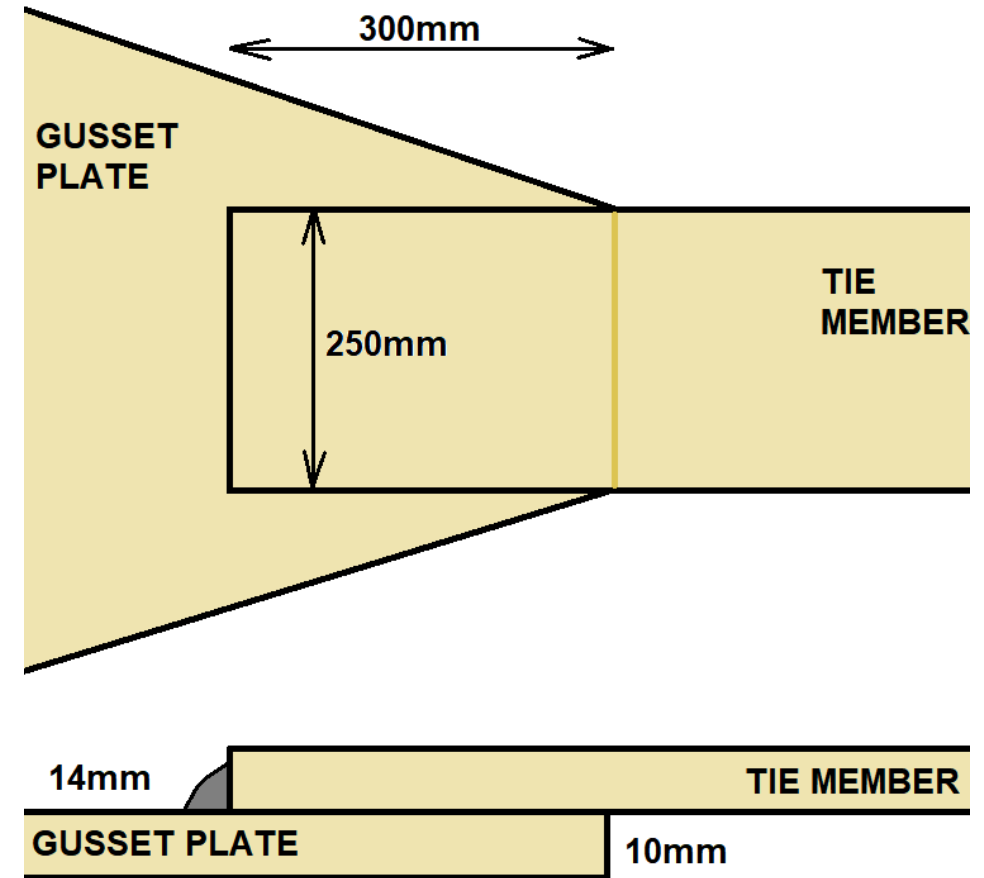
s = Min. 5mm = 6mm (from Table 21- Pg 78)

$t_e$  = 0.7 x 6 = 4.2mm

Substituting in above equation,

$$650 \times 10^3 = \frac{410 \times L_w \times 4.2}{\sqrt{3} \times 1.25}$$

$$\Rightarrow L_w = 817.24\text{mm} = \text{rounded to } \mathbf{820\text{mm}}$$

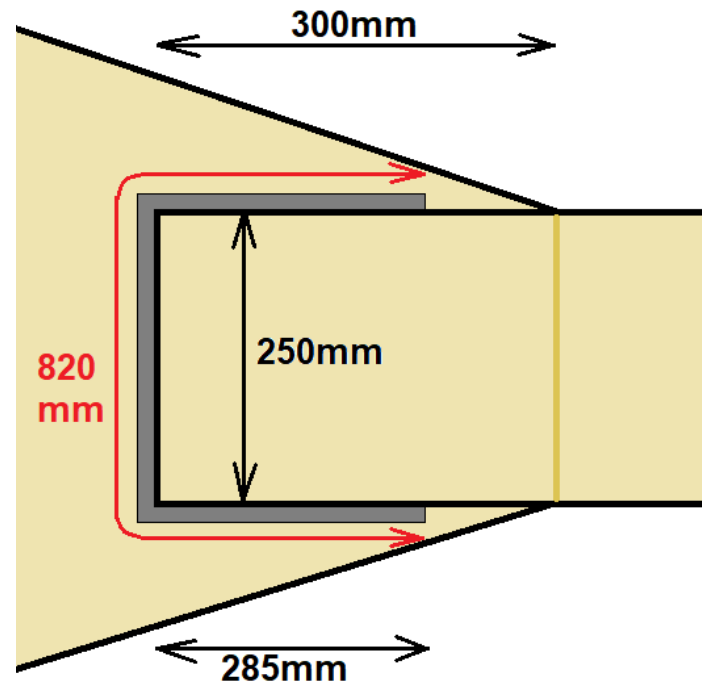




## NUMERICAL EXAMPLE 2

A tie member in a truss girder is 250mm x 14mm size, welded to a 10mm thick gusset plate, with an overlap of 300mm. Design the weld if it transmits a factored force of 650kN.

Hence, provide 6mm fillet weld over an effective length of 820mm as shown.



# NUMERICAL EXAMPLE 3

Calculate the safe load transmitted by a shop-welded joint if the size of weld is 6mm and its length is 330mm.

Answer:

Assume that the weld is of **FILLET** type.

Design strength of fillet weld,  $V_{dw} = \frac{f_u L_w t_e}{\sqrt{3} \gamma_{mw}}$

**(or Safe load transmitted by joint)**

$f_u$  = 410 N/mm<sup>2</sup> (assume Fe410 grade plate)

$L_w$  = 330mm

$\gamma_{mw}$  = 1.25 (for shopweld)

$t_e$  = 0.7s

s = 6mm

$t_e$  = 0.7 x 6 = 4.2mm

Safe load,  $V_{dw} = \frac{410 \times 330 \times 4.2}{\sqrt{3} \times 1.25} = \mathbf{262.50 \text{ kN}}$

# THANK YOU